Space Science: An Idea Factory for Global Security

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8 Sept 2010

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Los Alamos National Laboratory

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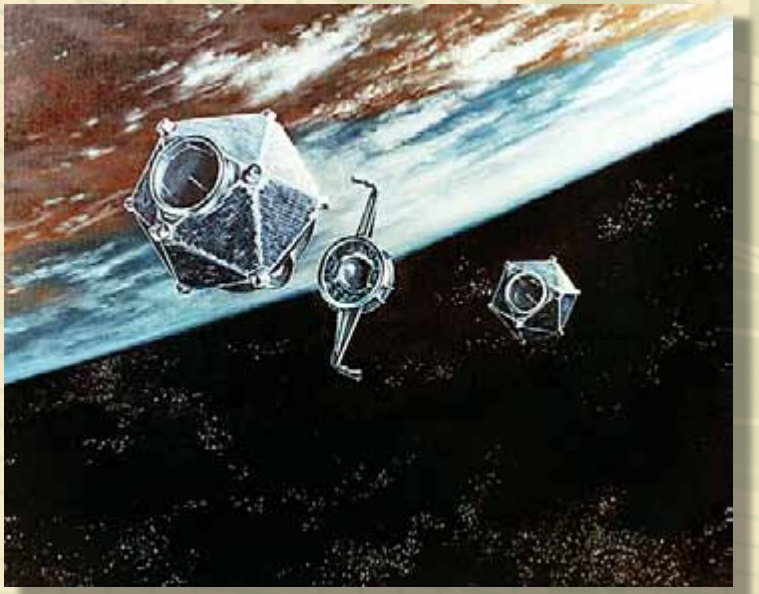
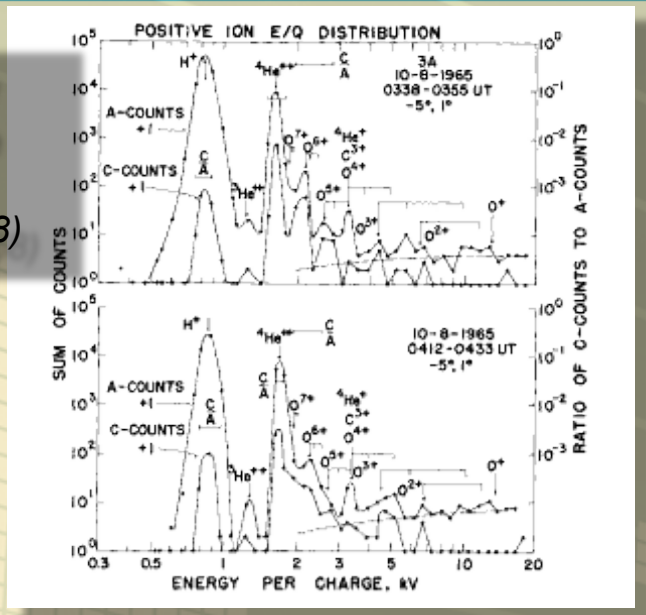
NNSA

The Vela Hotel Program, 1963-1984: *Monitoring the 1963 Limited Test Ban Treaty*

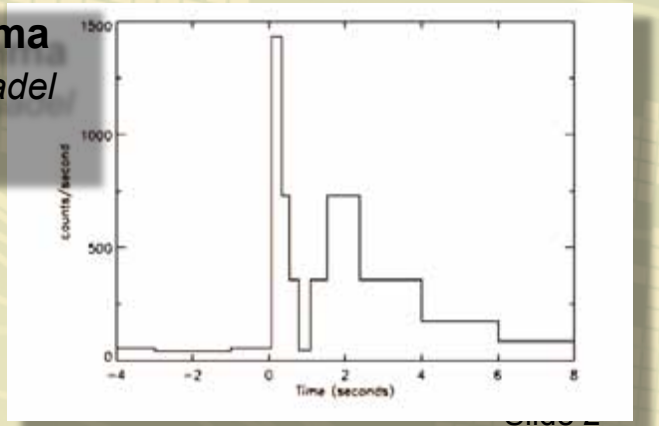
One person's background in another person's treasure…for scientific discovery



Discovery of Heavy Ions & High Charge States in the Solar Wind *(Bame et al., 1968)*



Discovery of Gamma Ray Bursts (*Klebesadel et al., 1973)*



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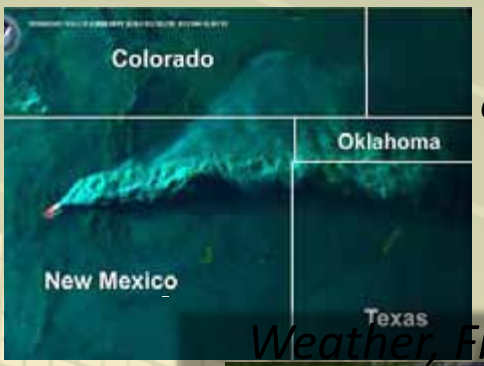
Space: Critical for Many Applications

Navigation



Cerro Grande

Greenland's Petermann Glacier

Climate change, disaster management, land use

Weather, Fires

Hurricane Earl

Deep Water Horizon (Digital Globe)

Communications

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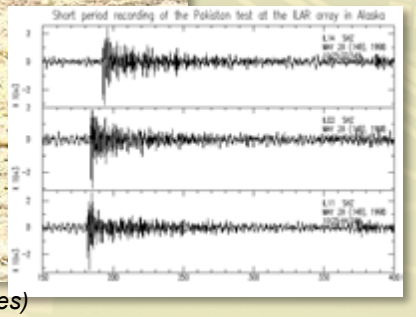
Out of the Cold War and into…
A Complex World and Evolving Threat

- Nuclear proliferation, e.g., Iran, Syria, N. Korea, Pakistan, India, …
- Proliferation of missile technologies
- Defense Threat Reduction Agency study, 2001: ***High Altitude Nuclear Detonations Against Low Earth Orbit Satellites***



Credit: Monterey Institute for International Studies)

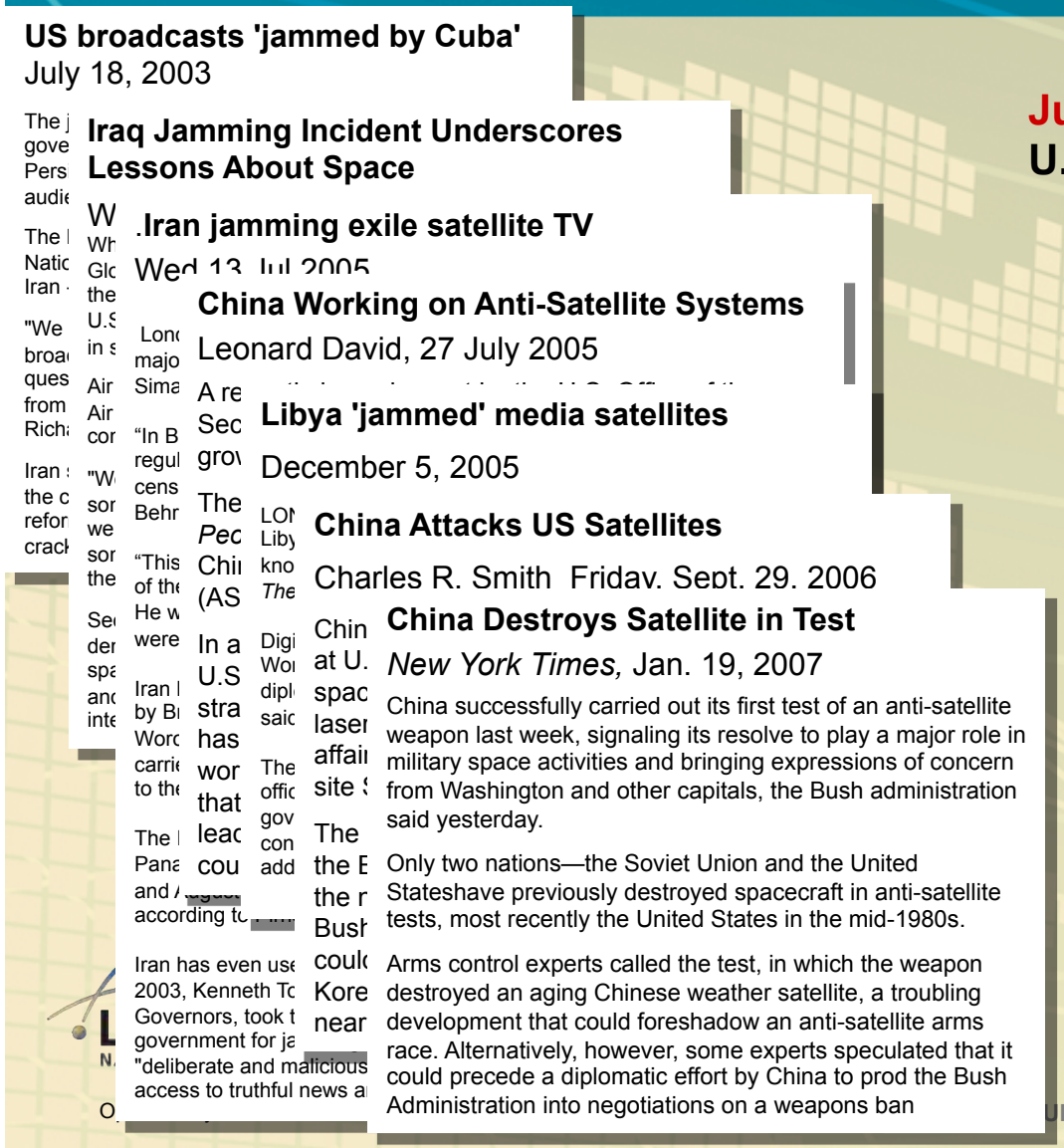
NATANZ, IRAN – CLOSE-UP

INSTITUTE FOR SCIENCE AND INTERNATIONAL SECURITY

IMAGE CREDIT: DIGITALGLOBE
DATE OF IMAGE: 16 SEPTEMBER 2002

THE GAS CENTRIFUGE URANIUM ENRICHMENT PLANT AT NATANZ, IRAN.

In the News: Threats to Use of Space



US broadcasts 'jammed by Cuba'
July 18, 2003

Iraq Jamming Incident Underscores Lessons About Space

Iran jamming exile satellite TV
Wed 13 Jul 2005

China Working on Anti-Satellite Systems
Leonard David, 27 July 2005

Libya 'jammed' media satellites
December 5, 2005

China Attacks US Satellites
Charles R. Smith Friday, Sept. 29, 2006

China Destroys Satellite in Test
New York Times, Jan. 19, 2007

China successfully carried out its first test of an anti-satellite weapon last week, signaling its resolve to play a major role in military space activities and bringing expressions of concern from Washington and other capitals, the Bush administration said yesterday.

Only two nations—the Soviet Union and the United Stateshave previously destroyed spacecraft in anti-satellite tests, most recently the United States in the mid-1980s.

Arms control experts called the test, in which the weapon destroyed an aging Chinese weather satellite, a troubling development that could foreshadow an anti-satellite arms race. Alternatively, however, some experts speculated that it could precede a diplomatic effort by China to prod the Bush Administration into negotiations on a weapons ban

July 2003 - Cuba jams TV signal from U.S. communications satellite

June 1997 – July 2005 - On-going jamming by Iran against PANAMSAT, AsiaSat, ArabSat, & Eutelsat

December 2005 - Libya jams two international communications satellites

September 2006 - China fires laser at U.S. satellites

January 2007 - China destroys low earth orbit spacecraft with direct ascent ASAT

Through LDRD investments, we are now answering these questions…

1) How can we improve the capabilities of our nuclear detonation detection mission?
2) What is the space weather now and in the future?
3) What is in space that we don't know about?

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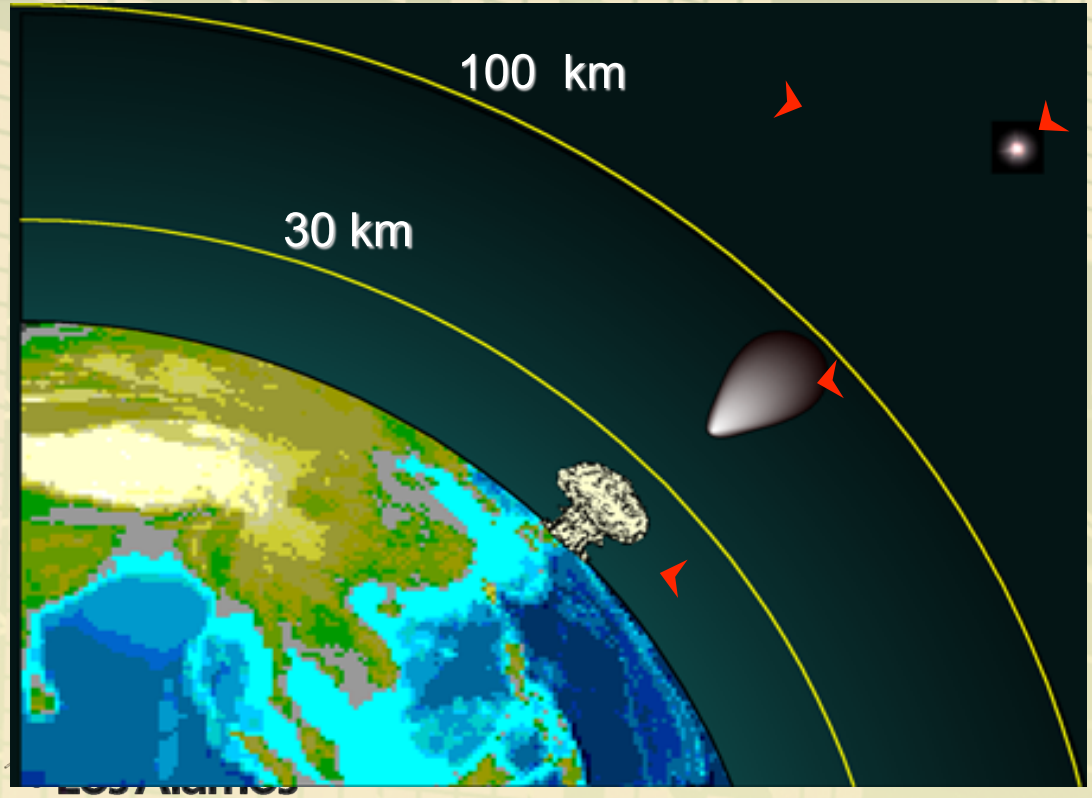
Los Alamos in Space: *Verification of the 1962 Limited Test Ban Treaty*

Space Environment

- Plasma (ions and electrons)
- Energetic particles (ions and electrons)



Space detonation

- Gamma Rays
- Neutrons
- X-rays

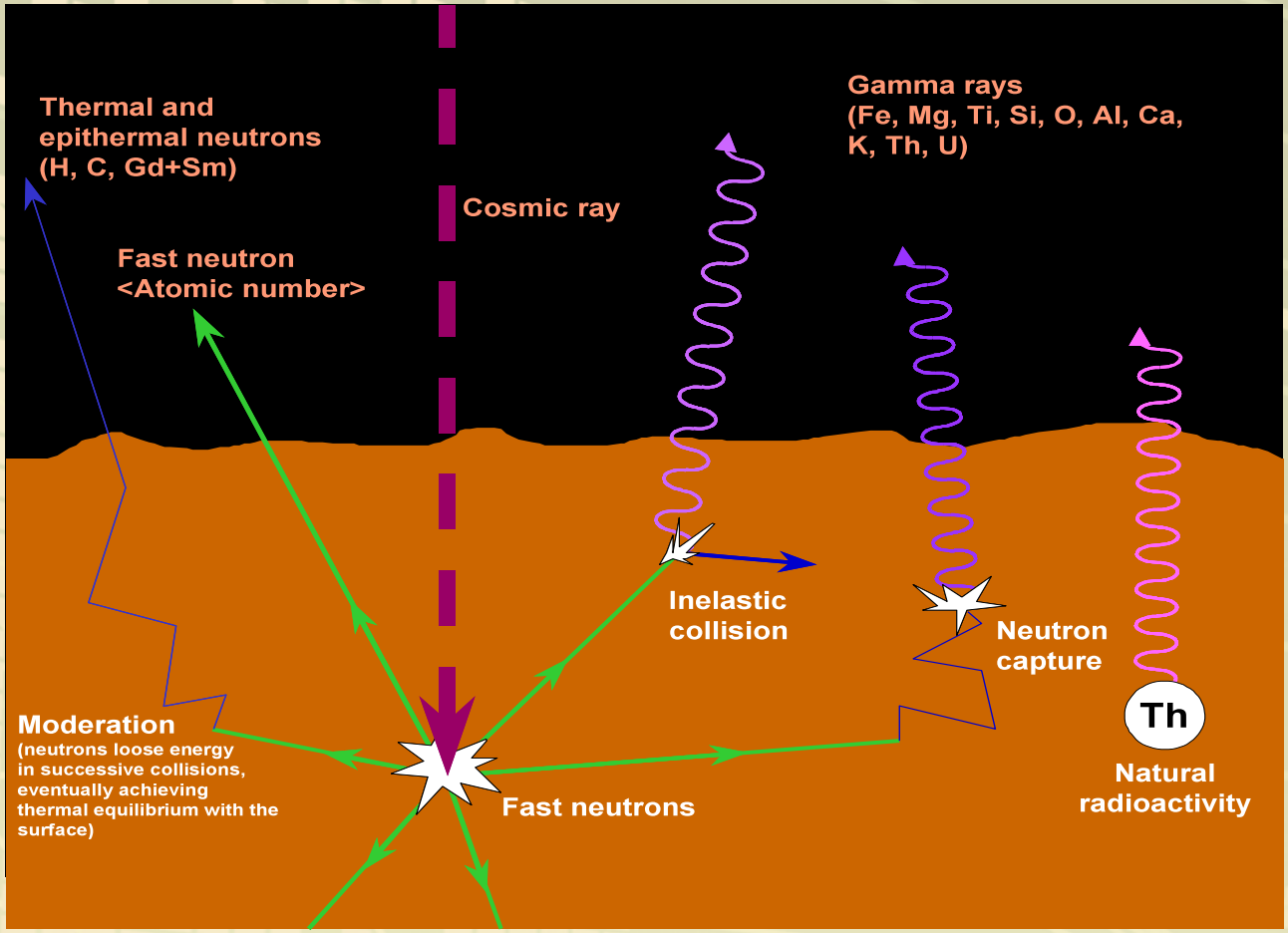
Transition Region detonation

- Optical
- Gamma Rays
- Neutrons

Low Altitude detonation

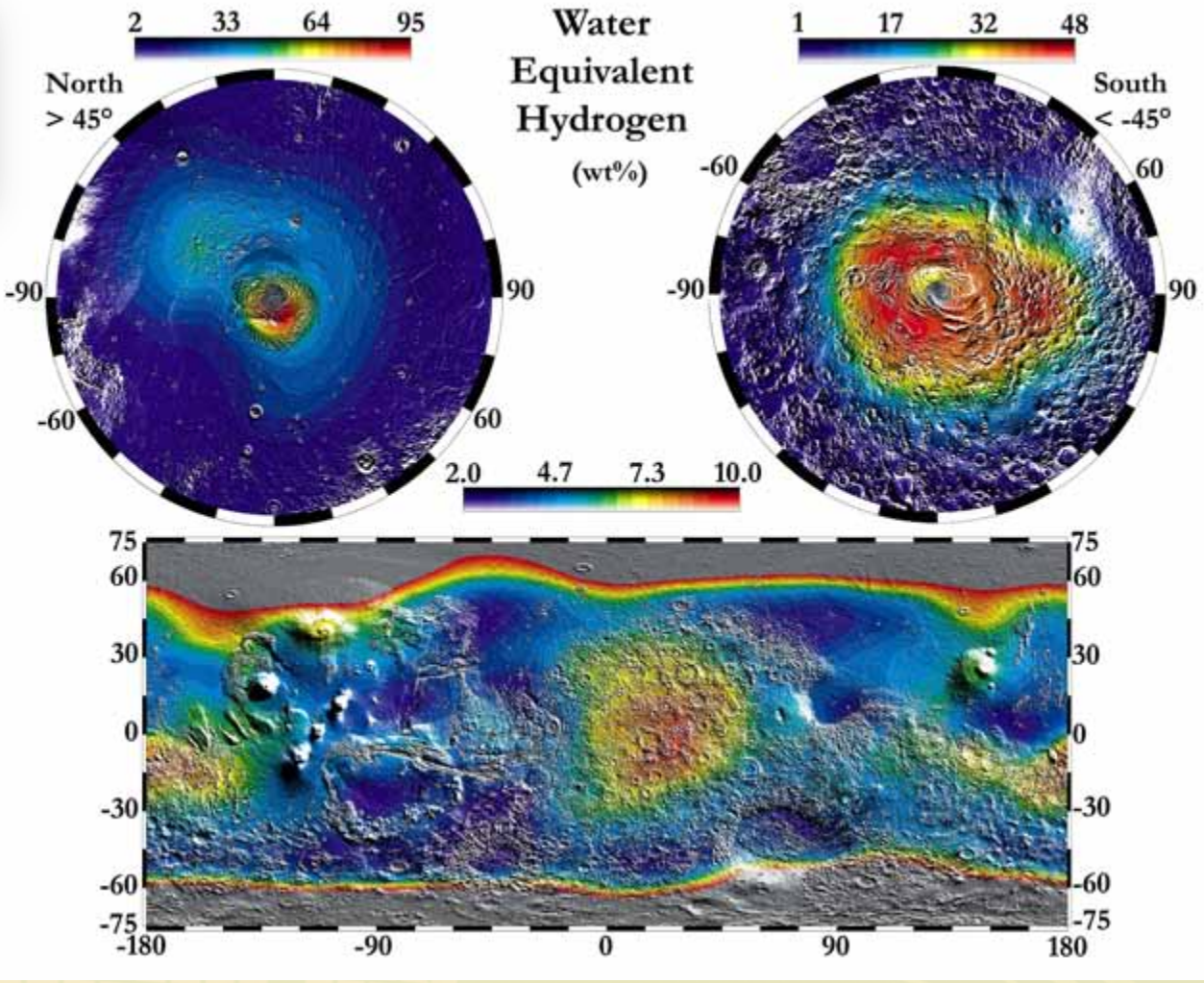
- Optical
- EMP

Neutron and γ-Ray Spectroscopy: Global Planetary Composition



The Search for Water: *Doppler Neutron Spectroscopy on Mars Odyssey*

LANL's Neutron Spectrometer on NASA's Mars Odyssey



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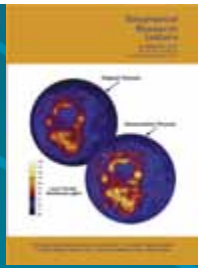
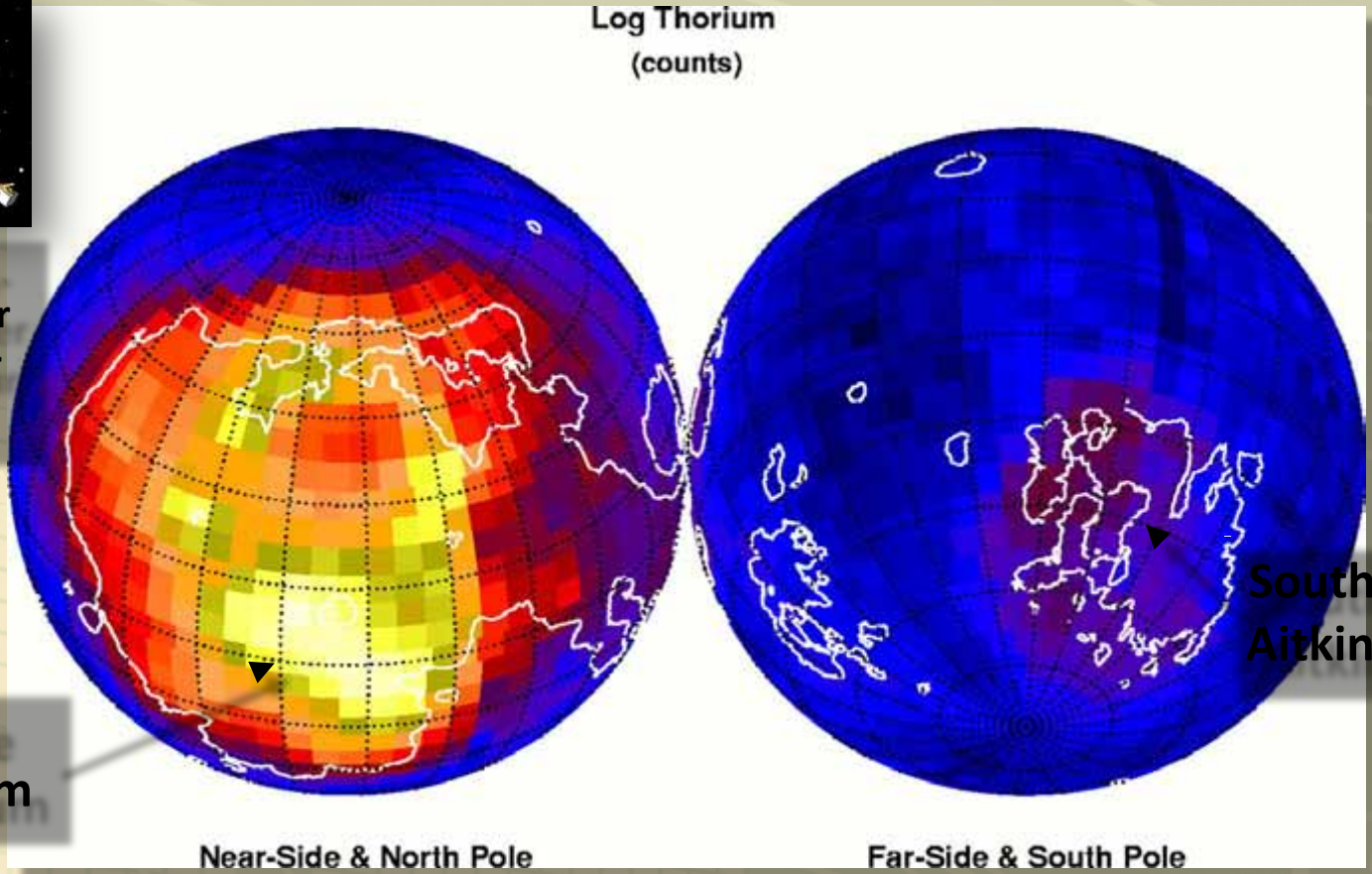
Lunar Prospector: γ-Ray Spectroscopy of the Moon



LANL's Gamma-ray Spectrometer on NASA's Lunar Prospector



South Pole-Aitkin Basin

Mare Imbrium

Thorium should be *enriched* between the crust and mantle. *Where is it?*

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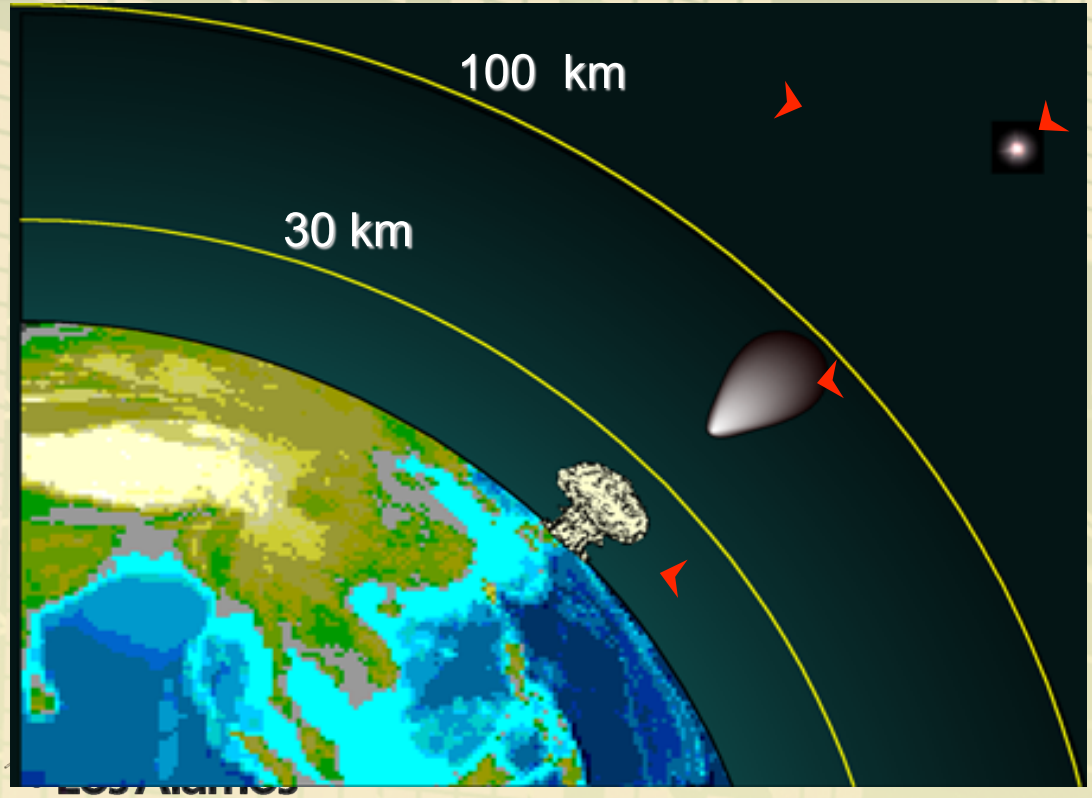

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- X-rays

Transition Region detonation

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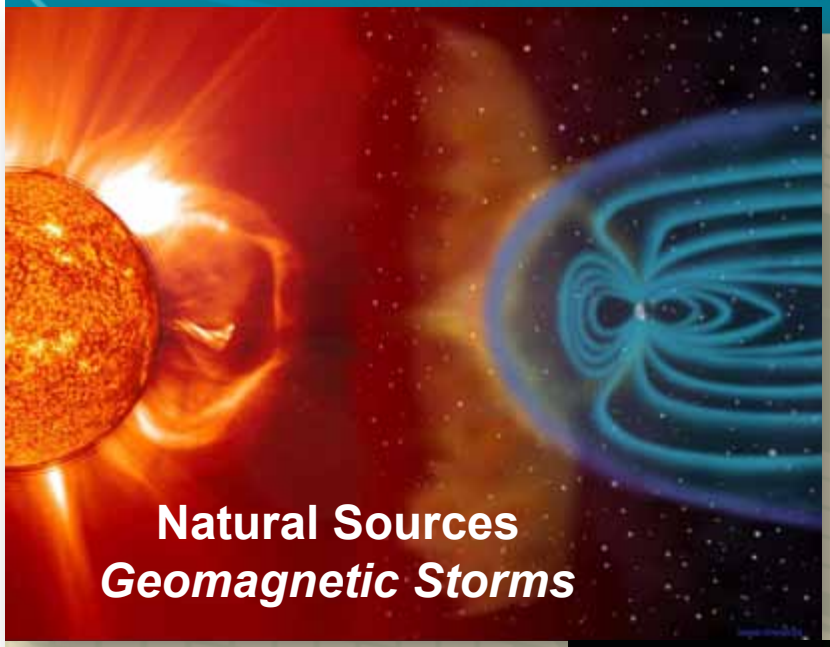
- Gamma Rays
- Neutrons

Low Altitude detonation

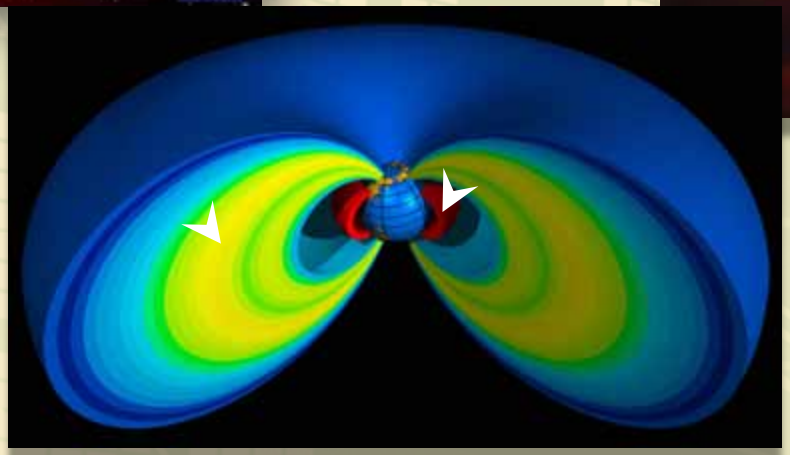
- Optical
- EMP

The Space Environment is Complex and Harsh



Natural Sources
Geomagnetic Storms

Nuclear Sources
Starfish, 1962, 1.4 MT



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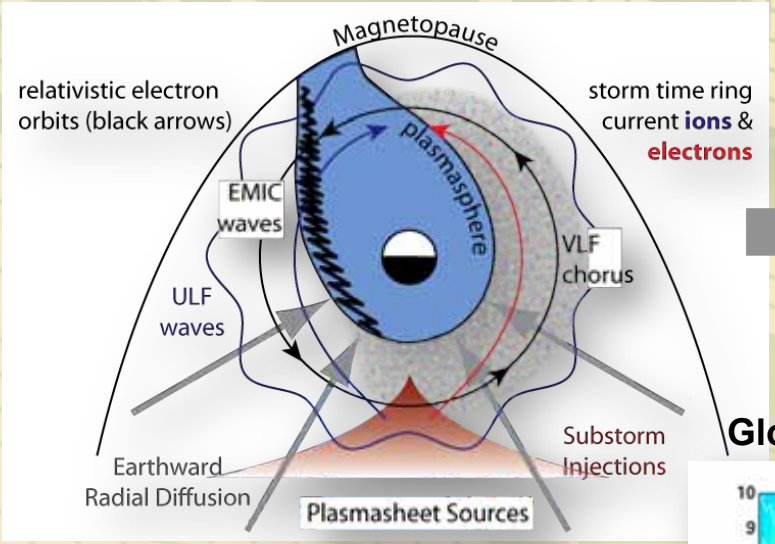
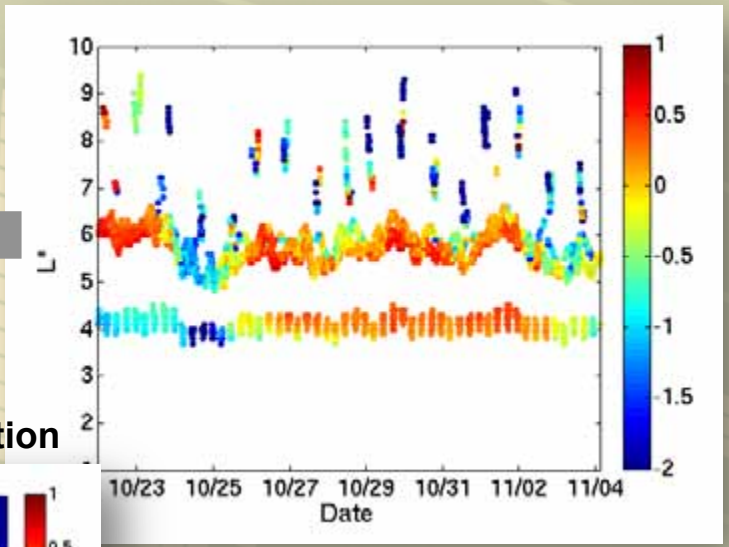
The Dynamic Radiation Environment Assimilation Model (DREAM): *Global Understanding of the Space Environment*

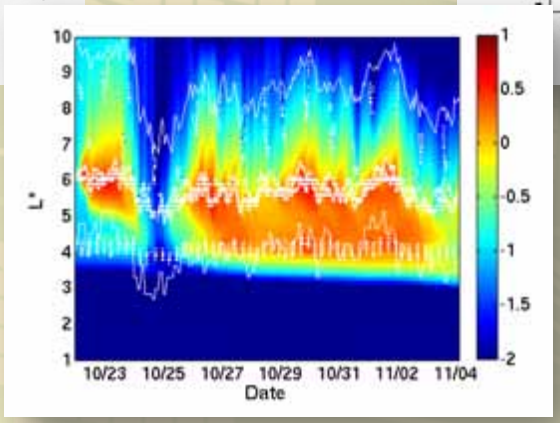
Complex Physical System



Sparse Observations



Global, Real-Time Solution

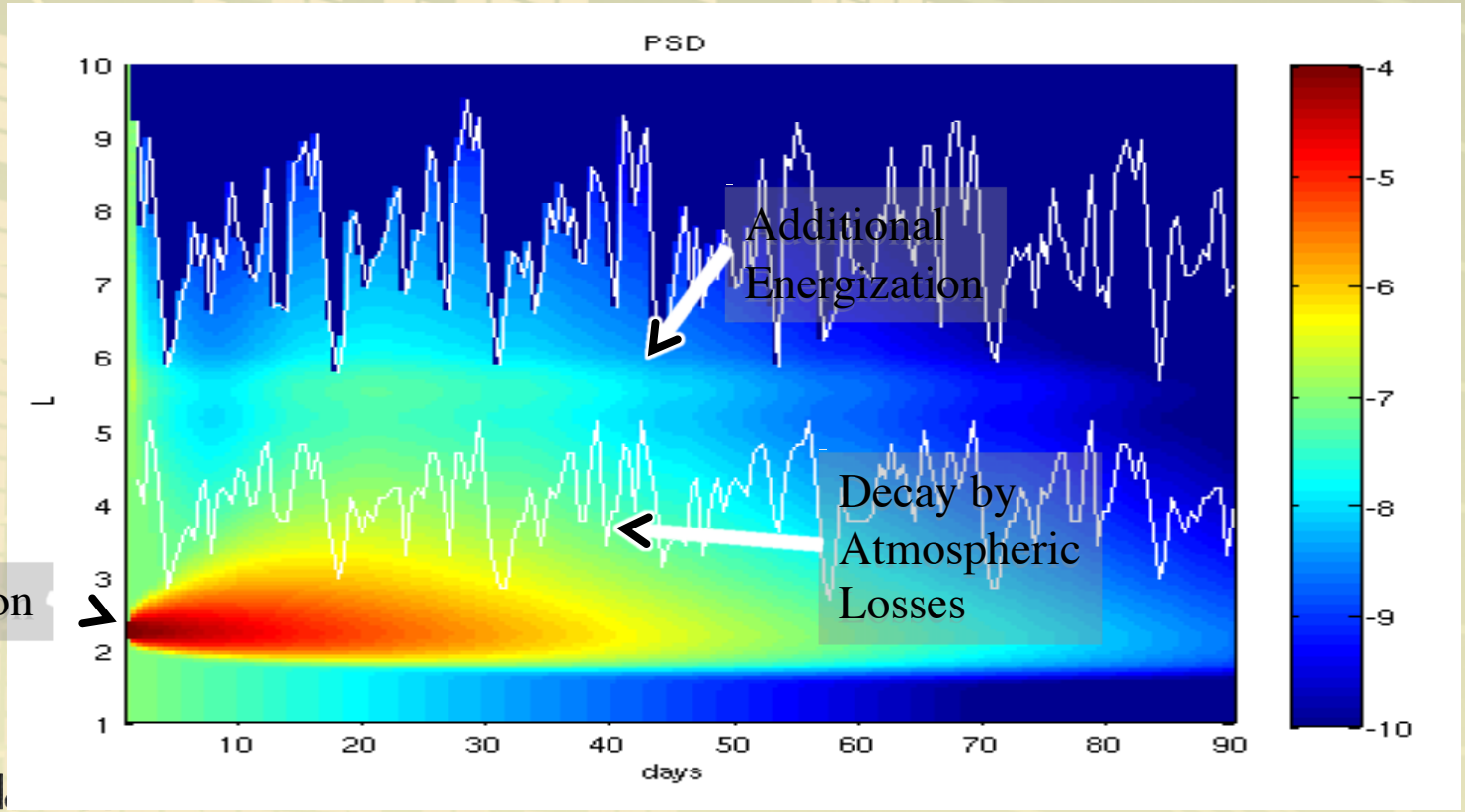


Definitively identified how electrons are accelerated in the Radiation Belts

Chen et al, Nature Physics, 2007

Nuclear Detonation in Space: *Effects on the Space infrastructure*

Evolution of nuclear detonation in space under different real conditions of the Earth's space environment



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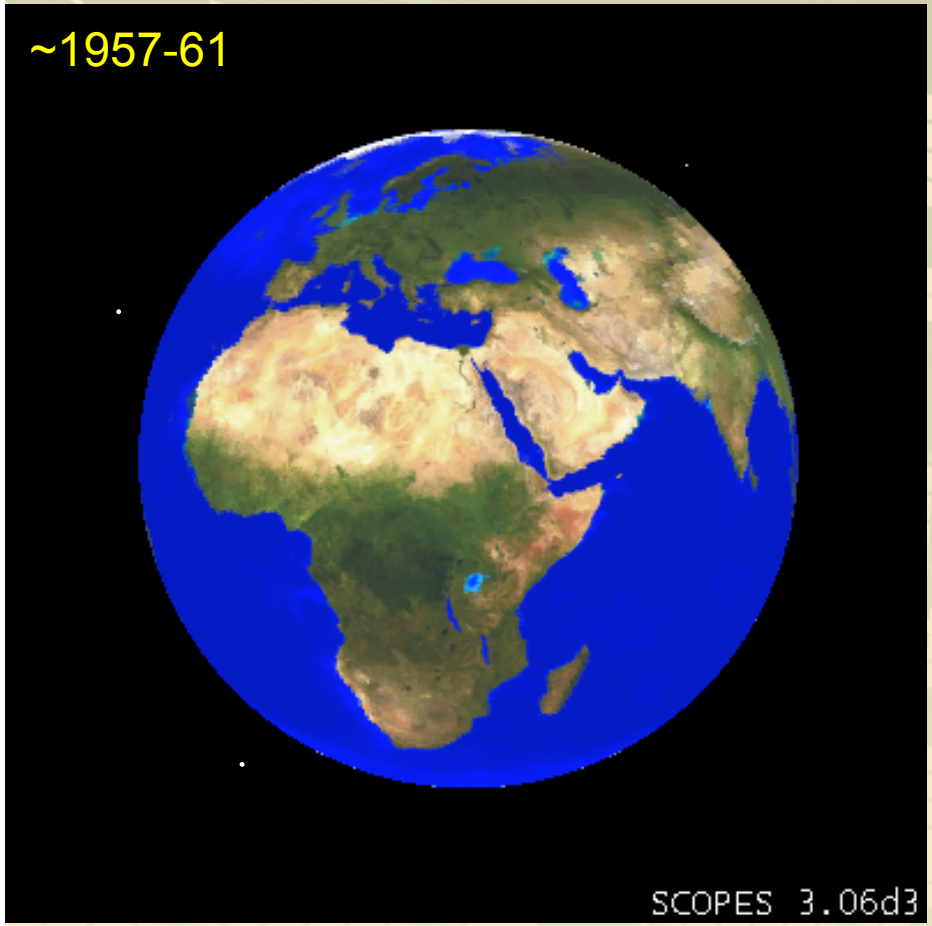
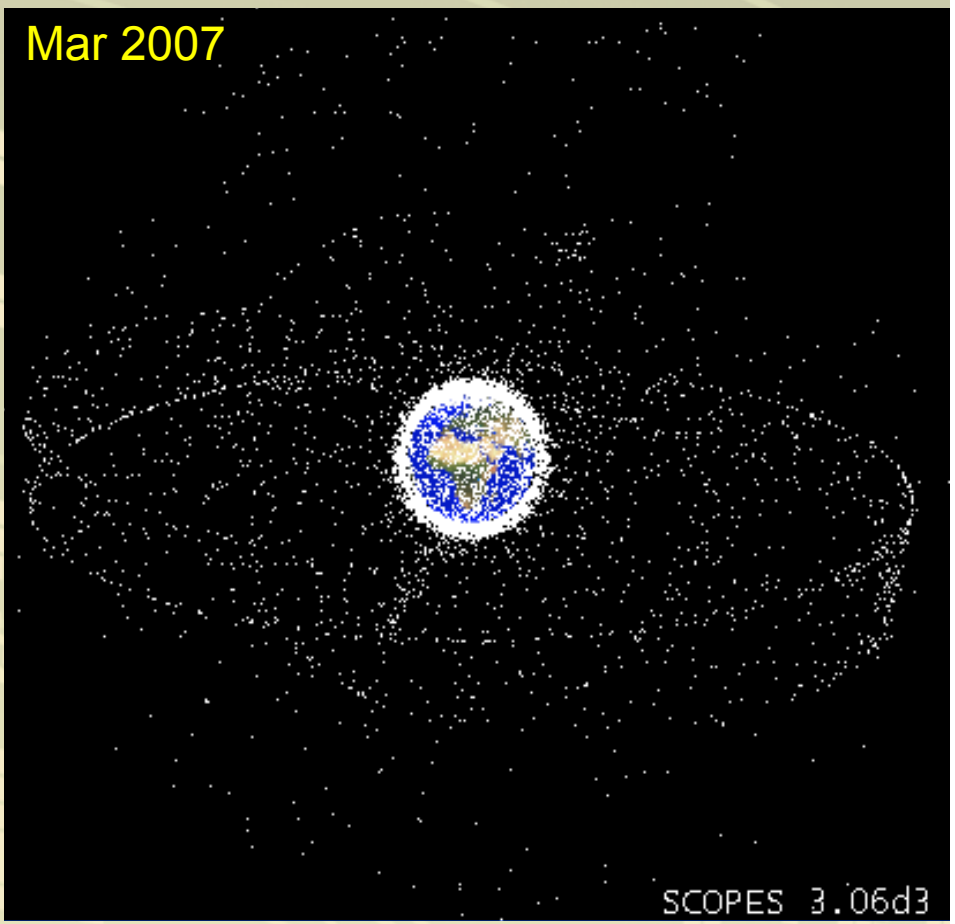
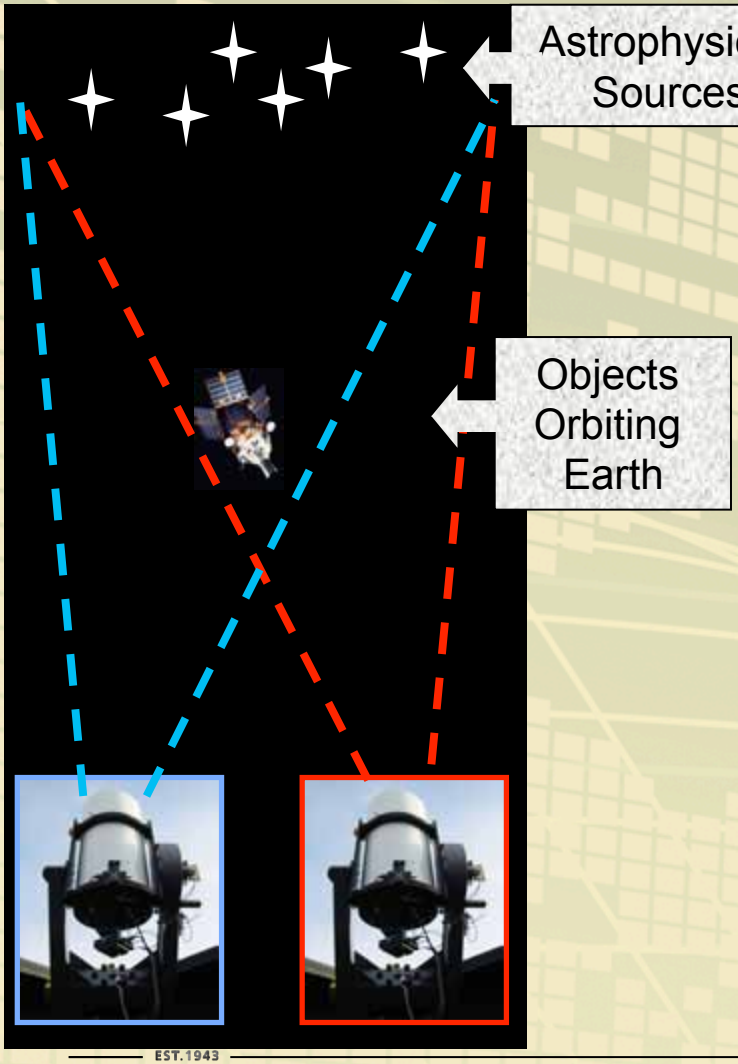
Approximately 9000 Large Objects Orbiting Earth, 3000 Useful Satellites

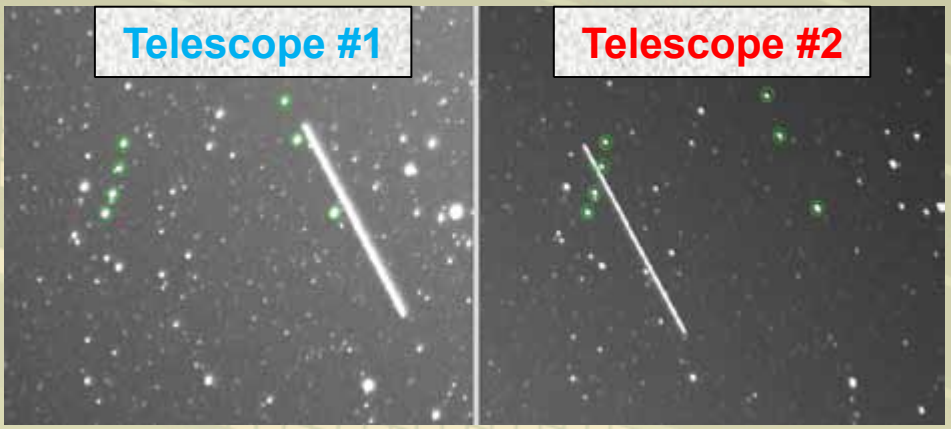




Tracked by United States Space Surveillance Network (SSN)

Thinking Telescopes: Discovering the Changing Sky

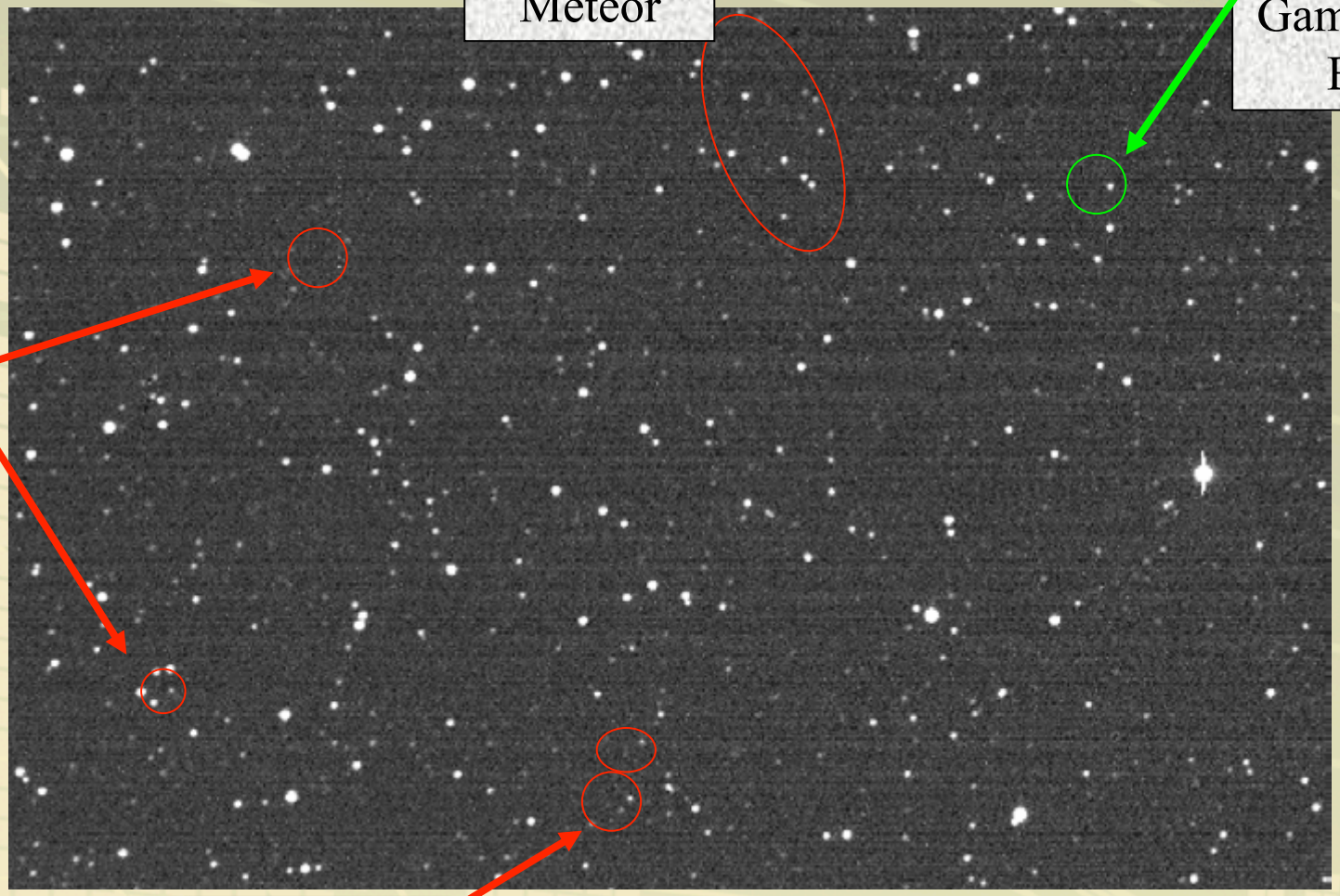




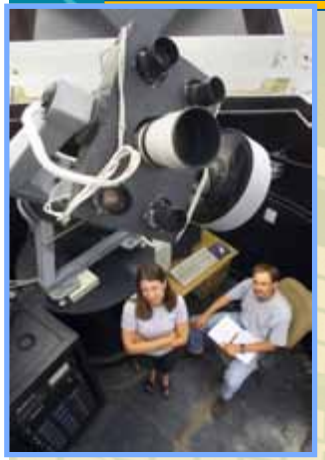
Parallax separates nearer Earth-orbiting objects from astrophysical sources:
~ 9000 Objects Orbiting Earth
~ 30,000,000 stars and galaxies visible

Autonomous system of telescopes on steroids:
- 10 telescope system in the Northern Hemisphere
- Massive processing capabilities, >300 Mbps
- Point to anywhere in the sky within 6 sec
- Scan entire night sky in 5-8 minutes

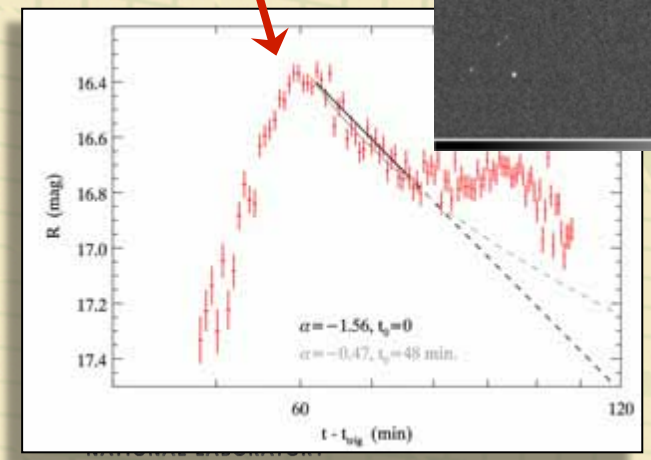
Thinking Telescopes: a 2 Minute look at 1/50,000 of the sky…



Thinking Telescopes: Discovering Gamma-ray Bursts



Gamma-ray burst

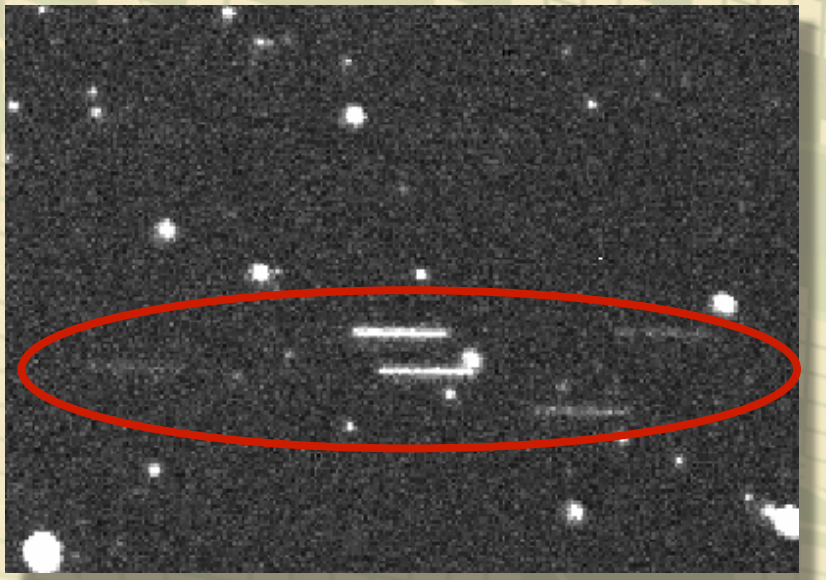


Discoveries (so far):

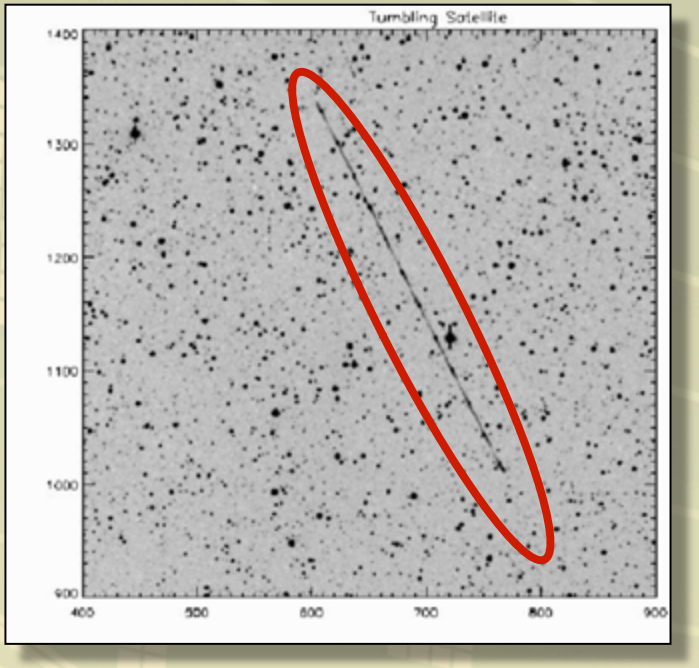
- Understanding of what drives supernova
- Burst from 7.5 BYA: Most luminous event observed in history, observable to the naked eye
- Oldest burst even observed: 13.2 BYA
- Optical flaring: burst with no accompanying gamma rays

skydot.lanl.gov

Thinking Telescopes: Discovering and Tracking Near-Earth Objects



Cluster of geo-synchronous spacecraft



Tumbling satellite with unique signature

Summary

- One person's background is another person's treasure: ***man-made signatures vs. natural backgrounds***
- Through scientific discovery: ***we can anticipate, discover, and understand national security threats***
- Science with a purpose: ***New signatures awaiting discovery and exploitation!***